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NEW SPECIES OF THE GORGONIAN GENUS *PLUMIGORGIA* (COELENTERATA: OCTOCORALLIA) WITH A REVIEW OF THE FAMILY IFALUKELLIDAE

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ABSTRACT

Three new species of the gorgonian genus *Plumigorgia* Nutting, 1910, are described and illustrated by scanning electron micrography. *P. terminosclera* sp.nov., *P. schuboti* sp.nov., and *P. astroplethes* sp.nov. were all collected on the Australian Great Barrier Reef. The family Ifalukellidae is summarised and a taxonomic key is given. All other known species of the family are also illustrated.

KEYWORDS: Gorgonian, Plumigorgia, Coelenterata, Octocorallia, Australia.

INTRODUCTION

The family Ifalukellidae Bayer, contains only 2 genera. The monobasic *Ifalukella* Bayer, 1955, and *Plumigorgia* Nutting, 1910, which contains 2 known species. Three more species of Plumigorgia are described below from a total of thirty-four specimens gathered together over a period of seven years with the valuable assistance of several people who are acknowledged later in this paper. Two of the species, *P. schuboti* sp.nov., and *P. astroplethes* sp.nov., have sclerites which are extremely unusual, appearing somewhat reminiscent of mineral specimens. The third species, *P. terminosclera* sp.nov., has sclerites of a form similar to those of P. hydroides Nutting, 1910, and *P. wellsi* Bayer, 1955, the two previously known species. Unlike those species, however, *P. terminosclera* has very few sclerites and sometimes none at all. When sclerites are present they are predominantly located on the terminal twigs in the younger parts of the colony.

The sclerites of all known members of the family are extremely small and scanning electron micrography has been used to illustrate them. Many of the photographs were taken recently by Heather Winsor at James Cook University, Townsville, others some time ago by Sue Doyle at Macquarie University, Sydney, and a few were taken by myself. The resulting images differ somewhat in their representation of the sclerite surface structure mainly as a result of being taken on microscopes of different vintage and employing different accelerating voltages in those machines. An attempt has been made to be consistent in choosing illustrations but in some instances different types of images have been mixed in order to display as great a range as possible of sclerite shapes. A series of photographs taken by Sue Doyle to illustrate the effect of varying the accelerating voltage on the images of both the object and the background are shown in Fig. 21.

There is a paucity of up to date keys for most groups within the Octocorallia. There may never be many species assigned to the family Ifalukellidae, however, the vast Indo-Pacific to West Pacific regions throughout which the known occurrances are scattered have seen little scientific exploration. With the introduction of three new species it is timely to summarise the group, with illustrations to supplement previous descriptions, and to include a taxonomic key which can be progressively updated and altered should new species, or further examples of described species, be found.

Abbreviations: NTM Northern Territory Museum of Arts and Sciences, Darwin; USNM United States National Museum, Washington; ZMA Zoological Museum, Amsterdam.

SYSTEMATICS

Plumigorgia terminosclera sp.nov.
(Figs 1-5)

Type material. All material except C2881 was collected from the Great Barrier Reef, Australia. HOLOTYPE - NTM C 5378, Davies Reef, 18°50'S 147°39'E, 15-20 m depth, July 1982, C. Wilkinson.

Fig. 1. *Plumigorgia terminosclera* holotype. Natural size.

PARATYPES - NTM C4175, NTM C5379, NTM C5380, NTM C5381, USNM 76295, data as for holotype; NTM C4995, same data but August 1981, 25-30 m depth, Z. Dinesen; NTM C4998, same data but 8-10 m depth; NTM C4497, NTM C4493, Broadhurst Reef, 18°58′S 147°41′E, 22 August 1981, 25-30 m depth, Z. Dinesen; NTM C4496, same data but 6-9 m depth; NTM C5382, Rib Reef, 18°30′S 146°52′E, 6 March 1981, Z. Dinesen; USNM 76296, Briggs Reef, 16°56′S 146°13′E, 1 December 1976, 5 m depth, P. Alderslade; NTM C2881, Marion Reef, 19°10′S 152°17′E, August 1977, 10 m depth, N. Coleman; NTM C4994, John Brewer Reef, 18°37′S 147°04′E, 15 February 1974, 6 m depth, P. Alderslade; NTM C5383, same data but 8 m depth, N. Coleman; NTM C2452, NTM C2486, Sanctuary Reef, Swain Reefs Complex, 22°04′S 152°41′E, 13 November 1980, 4-6 m depth, P. Alderslade; NTM C1259, Central Reef, Swain Reefs complex, 21°55′S 152°31′E, 6 November 1980, 27 m depth, K. Harada; NTM C2880, Swain Reefs complex, 9 September 1974, 25 m depth, N. Coleman.

Diagnosis. *Plumigorgia* colonies with a planar growth form, main branches slightly flattened, a stem that may be unusually long in large colonies and a small spreading holdfast. Terminal branching is alternate pinnate with the coenenchyme often slightly expanded at the base of the twigs. Axis highly calcified and often protruding from the tips of the twigs. Polyps most abundant on the twigs, where they are distributed all around, and totally retractile into the general coenenchyme or into low calyces. Sclerites not abundant and sometimes absent altogether. Oval to cylindrical in shape, with slight median constrictions, sclerites occur primarily on the tips of the terminal twigs in the younger parts of the colonies. Colonies slimy when alive and grey-brown with some violet-brown hues in the twigs.

Description. The pale yellowish-white holotype is a planar colony 195 mm in width and height (Fig. 1). A short main stem of approximately 4 mm in diameter extends from a small 15 x 7 mm spreading holdfast attached to a piece of coral rock. Branching commences 8 mm up from the base where the stub of a twig remains. The first major branch occurs 4 mm above this and is 2 x 2.7 mm in cross section just above its point of commencement. The majority of branches show some flattening due to a slight lateral expansion of the coenenchyne. The terminal twigs are up to 20 mm long but most are less than 15 mm. They arise from the main branches 2-3 mm apart in an alternating pinnate mode. The coenenchyme is slightly expanded at the twigs' base of attachment. Twigs in the older parts of the colony are up to 1.2 mm in diameter, while younger ones are 0.6 mm and less. The diameter of a twig remains roughly constant throughout most of its length except for the last few millimeters which taper to a fine point. It is not uncommon for a portion of naked axis to protrude from the tip of a twig. A few twigs bear small twiglets but most are unbranched.

Within the fan occasional anastomes occur, some of which consist of coenenchyme only.

Polyps occur scattered all around on the terminal twigs with 0.5-1.0 mm between polyp centres. On the branches polyps are few and irregularly distributed, being very scarce in older parts of the colony and more common in newer growths. On the twigs in some areas of the colony the polyps are retracted and occur as low domes about 0.60 mm across and 0.15 mm high. More commonly the polyps on the twigs are exert up to 0.53-0.72 mm across and 0.24 mm high. The short tentacles are often folded inward longitudinally down their midline. Tentacles are up to about 0.3 mm long and each has 1 row of 7 pinnules along each edge. Many of the polyps on the main branches are totally retracted and more or less flush with the surface. They appear very small and measure only 0.17-0.34 mm in diameter. The fine tapering extremities of the twigs are for the most part devoid of polyps.

The axis of the main stem is longitudinally ridged and has a golden-brown sheen. The axes of the main branches are smooth and have a golden yellow sheen. Tissue on the main stem is about 0.72 mm thick. Tissue on the twigs is of similar thickness but here the axes are very fine, 0.14 mm diameter, and whitish in colour with a satin-like lustre.

Sclerites, which only occur in the superficial layer of the coenchyme, are minute and mostly ovals and cylinders (Fig. 2A). Some are nearly circular in outline and a few have 4 lobes, but the majority are elongate and most of these are narrower across their centres and

appear somewhat peanut shaped in plan view. A number of sclerites have small cavities which appear as less dense patches when examined under a light microscope. The smallest sclerites are about 0.022 x 0.011 mm but most are longer than 0.029 mm with some of the larger measuring 0.051 x 0.026, 0.051 x 0.016, 0.045 x 0.022, 0.035 x 0.026 mm. One sclerite laying on its edge measured 0.034 x 0.008 mm.

Distribution of the sclerites with the colony is unusual as their occurrence is primarily restricted to the terminal twigs, with the greatest concentration being at the ends of the twigs. Twigs lower down within the colony tend to have fewer sclerites and many of them seem to have none at all. The main stem is devoid of sclerites as are the middle to lower regions of the branches. In areas where sclerites are present they can be seen in the surface tissue as minute white corpuscles. The distribution density varies between twigs. At their most compact they appear to be more or less touching but tissue is still visible amongst the mass. In other regions they are quite separate. In areas of the branches

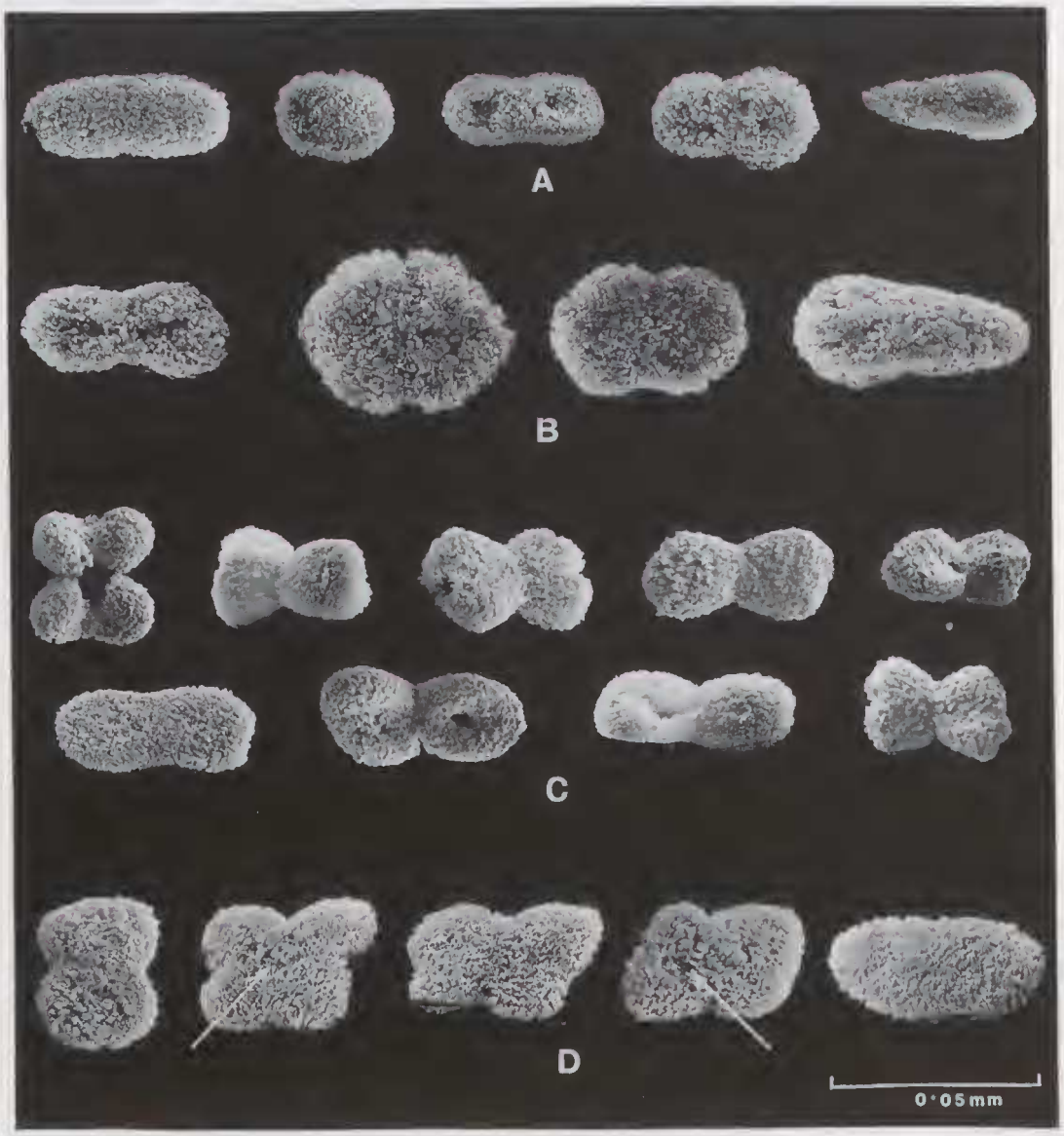

Fig. 2. Sclerites : **A**, *Plumigorgia terminosclera* holotype; **B**, *P. terminosclera*, paratype, NTM C2881; **C**, *P. wellsi* holotype; **D**, *P. hydroides*, USNM 59811.

Fig. 3. *Plumigorgia terminosclera* paratype, NTM C2486. Scale 20 mm.

where sclerites are absent, particularly in places where some surface tissue appears to have been rubbed off, an intricate subsurface canal system is visible in the transluscent coenenchyme.

Etymology. The specific epithet refers to the accumulation of sclerites at the ends of the twigs and utilises the Latin "termino" meaning to set limits or mark off boundaries.

Variability. Apart from one specimen the general colonial form of the paratypes compares very well with that of the holotype. There is some variation in the density of terminal branching and some differences in length and thickness of these branches, with 2 specimens each having several extra long twigs 25 mm in length. The shape of the twig tips also differs among colonies with some specimens having bluntly rounded tips, unlike the holotype. It is still common, however, for portions of axis to protrude from twig ends.

There is variation in the length of the main stem. On many of the colonies the lower branches have broken away or been shed from the stem with their positions being indicated by small remaining stumps. In many cases at least half the height of the colony is attributable to a branch-free stem which is virtually devoid of polyps (Figs. 3 and 4). In many colonies shallow longitudinal grooves can be seen on the stems where the stem canals have collapsed.

Most specimens have a few anastomoses. In the majority of cases these appear to be circumstantial where, either the colony architecture modified by local conditions had caused two twigs from neighbouring branches to attempt to grow through the same point in space, or the colony has been damaged and one portion of the fan has been caused to lay over another. Anastomoses do not always involve the axes. Presumably soft tissue fusing would occur initially with the axes coalescing with time or possibly only if the junction was subject to overmuch compression.

Regarding colour the type series can be split into 2 groups. The holotype together with 7 other specimens, 6 from the same population, were frozen after collection and subsequently preserved in 70% ethanol. All of these colonies are pale yellowish-white with polyps and tissue preserved in a relatively expanded state. Most of the other specimens were placed directly in 70% ethanol after collection, a couple were dried. All of these colonies are brownish-orange and the coenenchyme and, for the most part, the polyps have been preserved in a much more contracted and shrunken state.

Specimen NTM C5382 (Fig. 5B) deserves special mention as it has an abberrant growth form. The specimen consists of a portion of the main stem with some branches and two portions of the fan. The terminal twigs are placed quite close together and, curiously, curve towards the apex of the colony. The twigs are also unusual in that they gradually taper throughout their length to long fine tips. Many of the twigs have initially grown away from the plane of the main fan. Several small pinnately branched parts have also grown out of the main fan, but turned parallel to it, giving the specimen a slightly bushy appearance.

Specimen NTM C2881 (Fig. 5A) is a dry colony that has been rehydrated and, unlike the majority of the series, does not suffer the curvature gained from jar storage. In comparison with the previous specimen this colony's growth form is at the other extreme. It has grown strictly in one plane and has consistently short twigs, an unusually high percentage of which branch again into 1 or 2 small twiglets.

Amongst the paratypes most variability occurs in the distribution of the sclerites. The aforementioned specimen, NTM C2881, has the greatest amount of sclerites. As with the holotype, they are primarily concentrated in the twigs, being densest at the tips. They are so densely clustered that the terminal half of each twig was nearly white when the colony was dry. In many of the paratypes sclerites are difficult to locate and only a few twigs are found to have them, and often then they may be restricted to the last millimeter or two. Four of the paratypes NTM C5383, NTM C4993, NTM C4493, NTM C1259, do not appear to have any sclerites at all.

In general, with respect to size and shape, the fewer sclerites a colony has the smaller and less well developed they tend to be. In several colonies from the same population as the holotype the sclerites are very scarce and they are < 0.30 mm in length. In such colonies as these the sclerites are often poorly formed. Many are narrow and elongate while others have very thin waists. Their outlines

Fig. 4. *Plumigorgia terminosclera* paratype, USNM 76295. Scale 20 mm.

tend to be uneven and often pieces appear to be missing from the ends. Specimen NTM C2881 which has the most sclerites also has by far the largest which have been measured up to 0.072 x 0.029 mm. The smallest are about 0.030 x 0.011 mm while the majority are between 0.042 and 0.070 in length. Some are shown in Fig. 2B.

Field notes made for USNM 76296, C2452, C2486, C4994 and NTM C5383 indicate the live colonies were slimy.

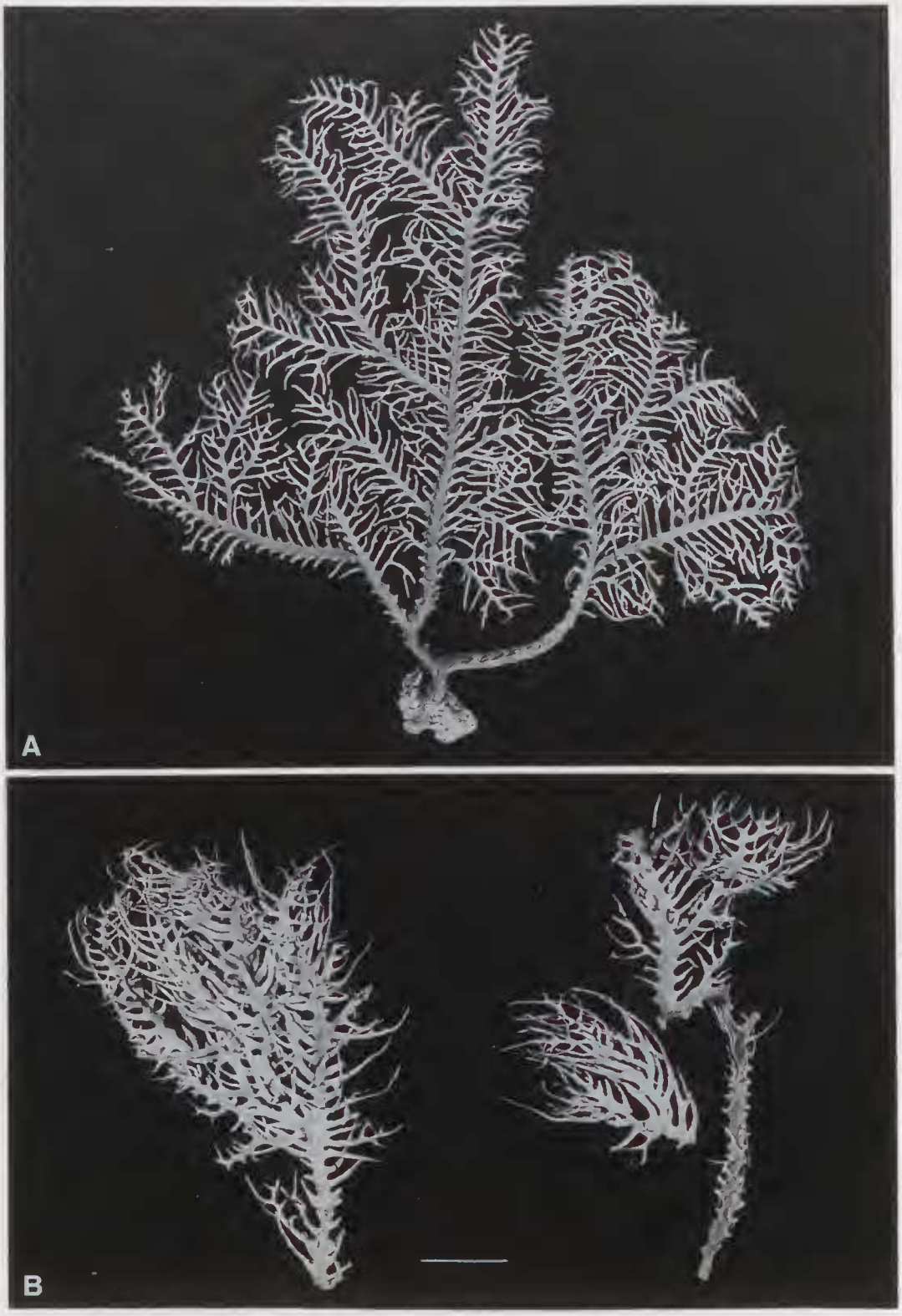

Fig. 5. *Plumigorgia terminosclera* paratypes: **A**, NTM C2880; **B**, NTM C5382. Scale 20 mm, both to same scale.

Plumigorgia schuboti sp.nov.
(Figs 6-12)

Type material. All material collected on the Great Barrier Reef, Australia. HOLOTYPE - NTM C767, Elford Reef, 16°55′S 147°17′E, March 1978, 3 m depth, R. Schubot. PARATYPES - NTM C766, NTM C5384, same data as holotype; NTM C349, Milln Reef, 16°47′S 146°17′E, February 1978, 10 m depth, R. Schubot; NTM C495, same data but 2 December 1976, 5 m depth, P. Alderslade; NTM C816, same data but March 1978, 7 m depth, R. Schubot; NTM C969, Moore Reef, 16°52′S 146°14′E, November 1978, 7 m depth, R. Schubot; USNM 76297, Briggs Reef, 16°56′S 146°13′E, March 1978, P. Alderslade.

Diagnosis. *Plumigorgia* colonies with a planar growth form, main branches slightly flattened, short main stem and a small holdfast. Terminal branching alternate pinnate with the coenenchyme slightly expanded at the base of the twigs. Axis highly calcified and often protruding from the tips of the twigs. Polyps all around on twigs and branches and totally retractile into the general coenenchyme or into low calyces. Sclerites are rodlets, ovals and crosses, often with a highly crystalline appearance and angular projections, forming a dense meshwork in the surface layers of the coenenchyme. Colour in life grey with violet hues.

Description. The blonde coloured holotype (Fig. 6) is 135 mm high by 130 mm

Fig. 6. *Plumigorgia schuboti* holotype. Natural size.

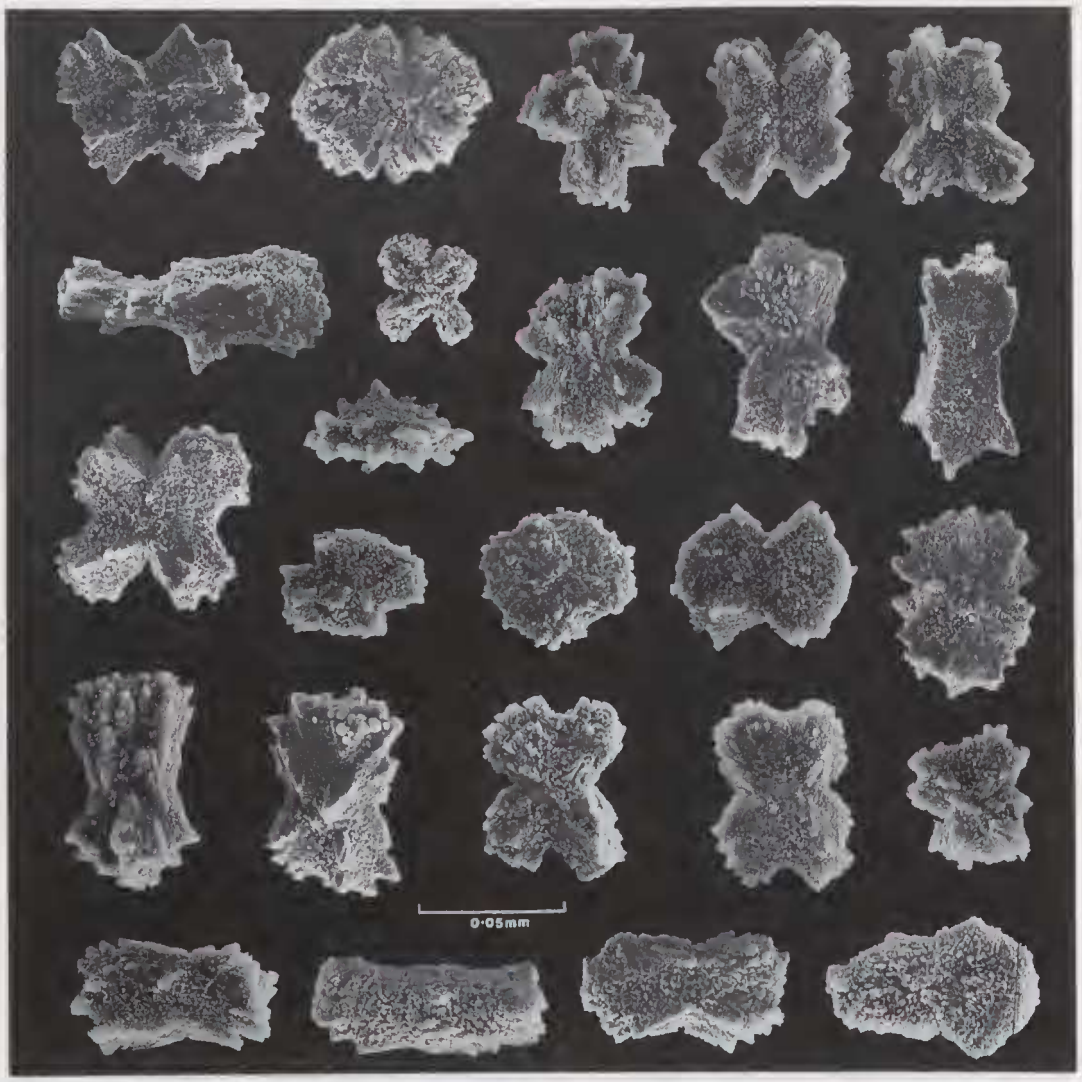

Fig. 7. *Plumigorgia schuboti* holotype, sclerites.

broad, quite stiff, and profusely branched in one plane. At the base of the colony there is a strongly calcified holdfast. Branching commences within 10 mm of the place of attachment and some anastomosing has occurred in this area.

The main branches are slightly flattened, 2-2.5 mm wide and roughly oval in cross section. This ellipsoid section is due solely to a bilateral thickening of the coenenchyme as the axis is roughly circular in section.

The terminal twigs are up to 15 mm in length but most are less than 8 mm. They arise 2-3 mm apart in an alternating pinnate mode from the main branches and branchlets. Occasionally pinnate twigs bear small twiglets 1-3 mm in length, but usually they are unbranched. At their base of attachment the coenenchyme of the twigs is slightly expanded. Above this the twigs are 0.7-0.9 mm thick and taper to a tip which may be rounded or acutely pointed. It is not uncommon to find a short portion of the axis protruding from the end of a twig. The axis in the stem and main branches is grooved longitudinally and has a golden sheen. The coenenchyme on the main stem is about 0.4 mm thick. In the terminal twigs the axis is white to yellowish-white with a satin-like lustre and its diameter is approximately ⅓ that of the twig. Most of the polyps are retracted. Those on the larger branches and twigs are flush with

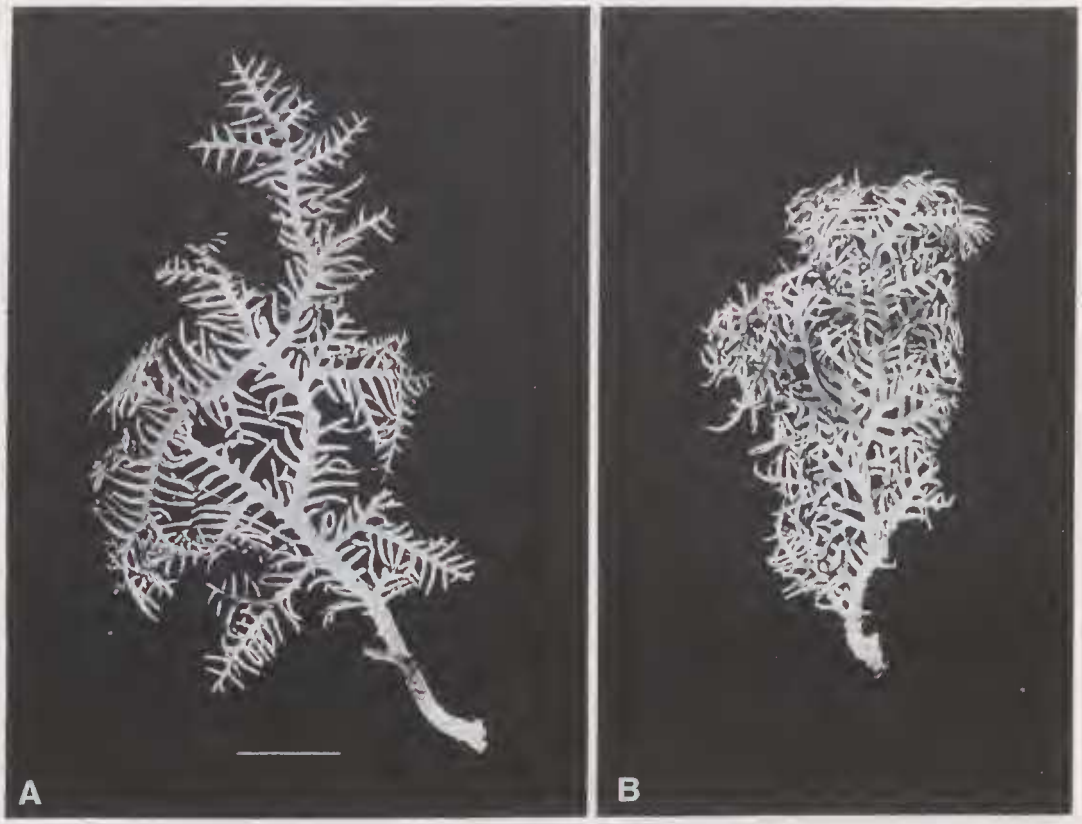

Fig. 8. *Plumigorgia schuboti* paratypes: **A**, NTM C816; **B**, NTM C5384. Scale 20 mm, both to same scale.

the surface and appear as sclerite-free yellowish grey patches approximately 0.2 mm in diameter. Those on the branches are commonly slightly swollen and appear as low mounds. A small number of polyps are partially expanded showing a flattened oval disc surrounded by 8 very contracted tentacles. These polyps are about 0.29-0.48 mm high and 0.12-0.24 mm in diameter. On the terminal twigs the polyps are distributed all round with 1-2 polyp diameters separating them. On the main branches however, the distribution is quite erratic. They occur sparingly in the lower parts increasing in numbers distally and about 0.5-5 mm separate individuals.

Sclerites are distributed over the whole of the colony surface, with the exception of the polyps. Under a low power microscope the sclerites on the twigs appear as small white rodlets amassed densely but haphazardly on the surface. On the main branches closer examination of many areas reveals the sclerites aggregated into a loose mesh-like arrangement with the terminal sacs of an intricate subsurface canal system appearing as minute whitish to clear patches within the mesh.

The sclerites occur in the outer layer of the coenenchyme and appear to be derived from basic rod shapes which are often present as a form of interpenetration twins at various angles The resulting shapes (Fig. 7) with their gross crystalline surface sculpture are unlike the sclerites of any gorgonacean described until now. Vaguely reminiscent of the sclerites of some pennatulaceans and the crystal-like bodies found in *Clavularia ochracea* Von Koch, 1878, by Weinberg (1978), they are more like mineral specimens of non-biogenic origin. A notable feature of the sclerites is that virtually all of them possess prominent angular projections. Most sclerites have many of these projections while others possess only a few larger ones. These somewhat ridge-like, pyramidal or block-like prominences do not have the coarse crystalline sub-unit architecture seen on the rest of the sclerite surface. In mineralogy such an

occurrence might be attributed to primary crystallisation with the smaller crystals in-filling secondarily. If, however, the process of biomineralisation resembles that described by Kingsley and Watabe (1982) the projections may be precipitated last and are finer due to a denser organic matrix. Although there is no evidence to support the idea of a secondary crystallisation occurring I shall refer to the material deposited between the prominences, which varies between specimens, as "in-filling", purely to assist in describing their visual appearance.

The majority of sclerites are >0.053 mm in the longest axis. The largest crosses are about 0.081 x 0.065 mm but most are smaller. The largest rod-like forms are rarely larger than 0.081 x 0.041 mm, while shorter ones maybe fatter. There are many sclerites 0.049-0.069 mm in length and the occasional oval form about 0.037 x 0.016 mm with a median constriction resembling the sclerites of *P. terminosclera*.

Etymology. This species is named after Mr Richard Schubot who collected most of the material.

Variability. Among the specimens of the type series there is considerable variation, particularly in colony morphology.

Specimen NTM C816 (Fig. 8A) is yellowish brown and darker than any of the others. It is also conspicuous because of the very strong flattening of the main branch, which is 4 mm wide. The colony also has an unusual aspect because the main branches ramify at right angles. The twigs are thicker than those of the holotype and the whole colony is quite flexible. The sclerites (Fig. 9A) have more pronounced ridges than the holotype and the "in-filling" is of a much finer structure.

Specimen NTM C349 is a stiff wiry colony and morphologically similar to the holotype although the terminal twigs are slightly closer together. An unusual amount of shrinkage

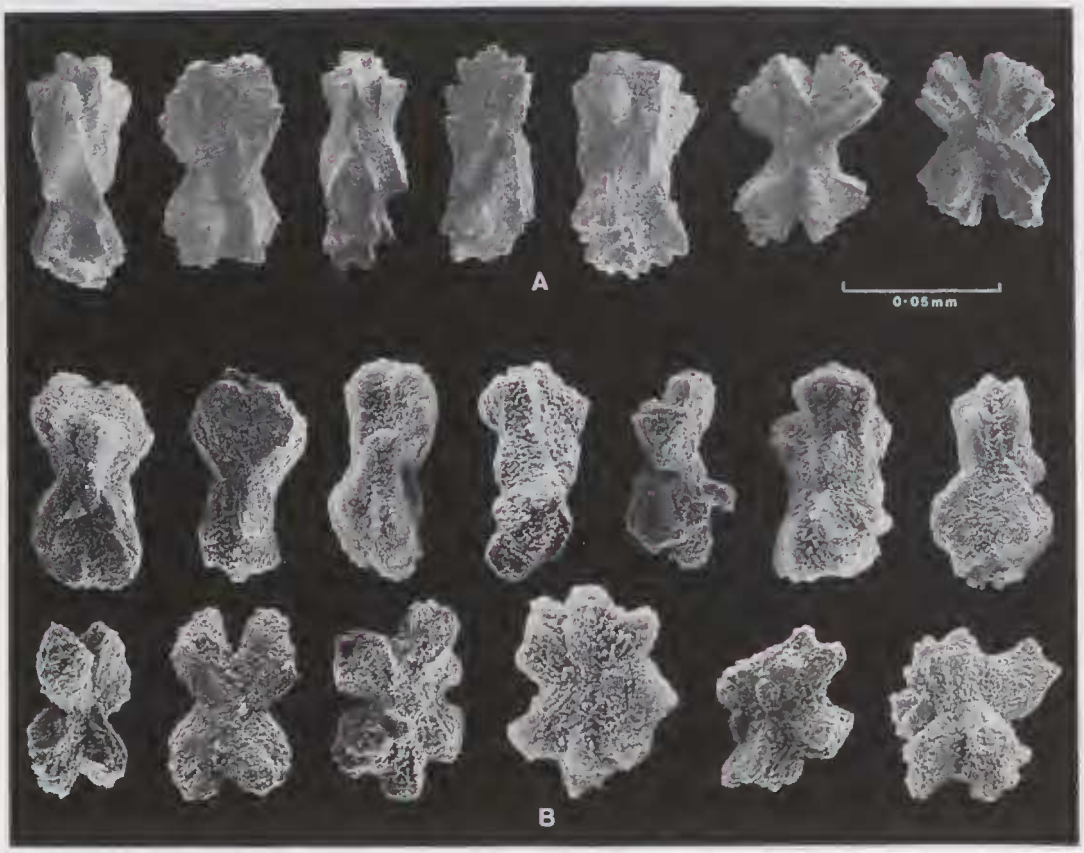

Fig. 9. *Plumigorgia schuboti* paratypes: **A**, sclerites from NTM C816; **B**, sclerites from NTM C969.

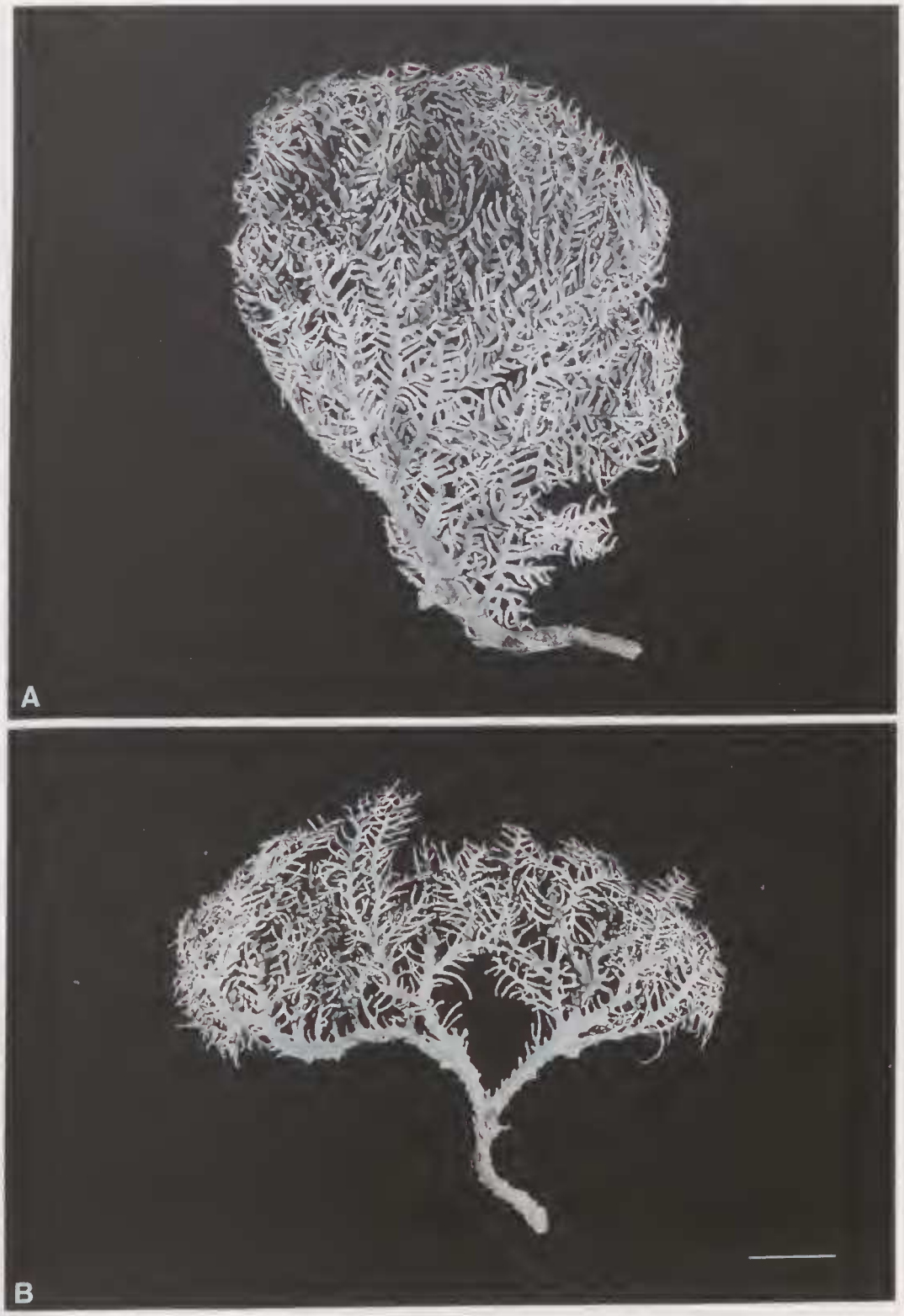

Fig. 10. *Plumigorgia schuboti* paratypes: **A**, NTM C766; **B**, USNM 76297. Scale 20 mm, both to same scale.

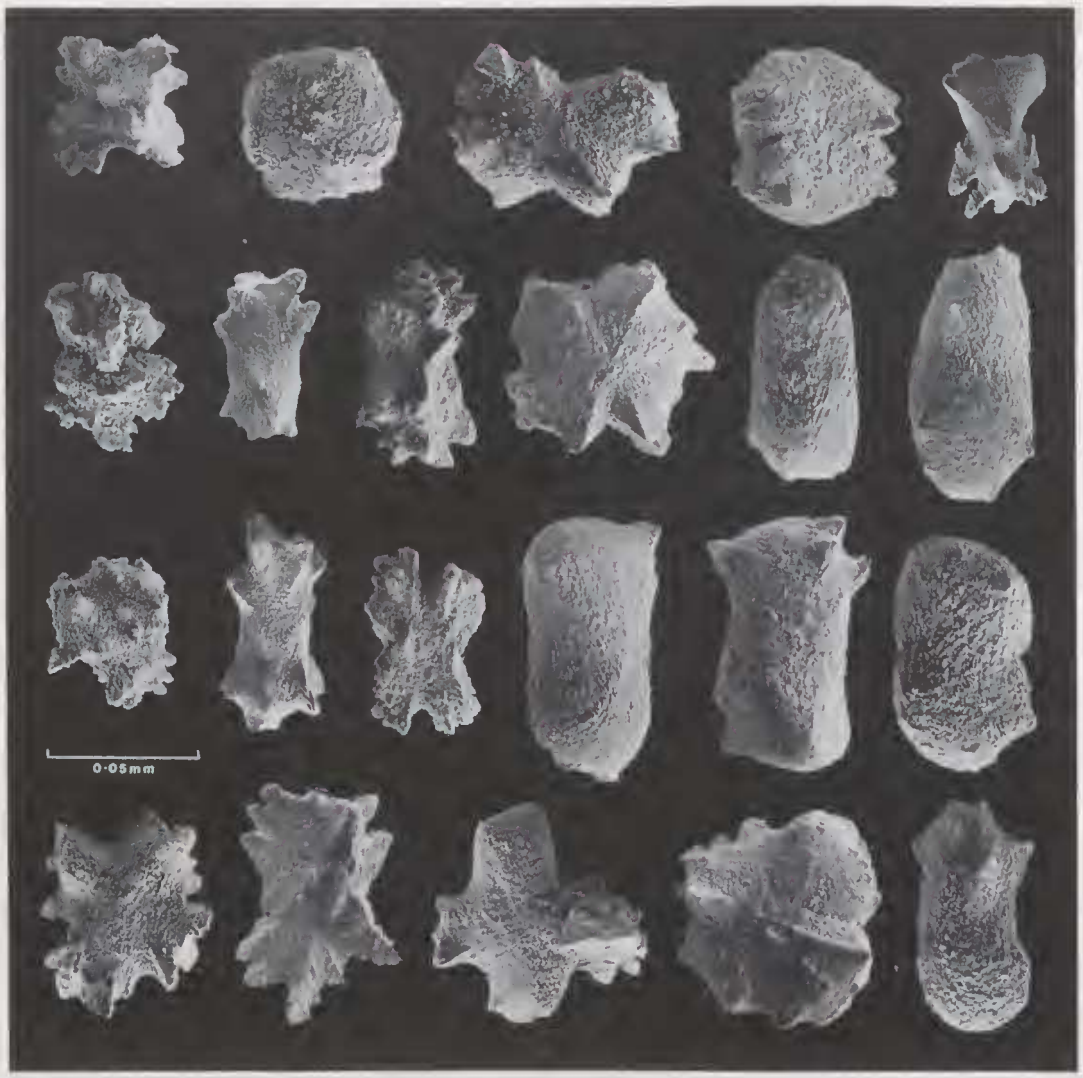

Fig. 11. *Plumigorgia schuboti* paratype, NTM C766, sclerites.

appears to have taken place during preservation as a result of which a ridge of tissue runs above the axis along the flatter faces of the branches. The small web of coenenchyme at the base of the twigs is quite obvious and on the branches the loose meshwork of the sclerites is easily observed. Most of the polyps are contracted flush with the surface or into shallow pits. The sclerites are less angular than those of the holotype, there is more "in-filling" and some of the rods are slightly bulbous.

Specimen USNM 76297 (Fig. 10B) differs very little from the holotype in specific characters. The colony is broader, lacks a base and the lower 70mm has the secondary branches missing.

Colony NTM C766 (Fig. 10A) is quite remarkable for its luxuriant growth form. The specimen is stiff and has extremely dense branching with a number of anastomoses. The terminal twigs are relatively thick, being up to 1.8 mm wide at the base. They arise very close together, sometimes nearly touching. Numerous twigs arise more or less at right angles to the growth plane on one side of the colony and curve upwards. The majority of the polyps on both twigs and main branches are retracted into low calyces while some appear as small pits. The sclerite

meshwork is visible but not obvious in the surface tissue. The sclerites (Fig. 11) reflect the robust growth form of this colony. They are noticeably larger than those of the holotype, being up to 0.098 mm in length. A few have well defined ridges and processes as seen in specimen C816, but many are "in-filled" to such a degree that these processes are all but obliterated and quite bulbous forms have resulted. Of particular interest are the unusual and uncommon forms shown in Fig. 12 where the "in-filling" is profoundly asymmetrical.

The apparent overcalcification of the sclerites of this specimen may have solely been due to its genetic make up. It is however tempting to theorise along the lines of Simkiss (1980) who postulates that calcium carbonate deposition may wholly or partially occur as a result of a detoxification process lowering excessive concentrations of calcium ions through biomineralisation. There is a small amount of evidence (Kingsley and Watabe 1982) that some extracellular precipitation may even be possible. It is certainly not difficult to envisage specimens growing in an optimal environment producing luxurious growth and becoming encumbered with an excessive build-up of minerals. *P. schuboti* could prove an interesting study in this field.

Specimen NTM C5384 (Fig. 8B) is smaller than NTM C766 but similar to it in most respects.

Specimen NTM C969, which is only a portion of a colony, is quite lax. The terminal twigs average >10 mm in length with the largest measuring 17 mm. On the main branches there is a slight furrow along the centre of the flattened faces, the loose sclerite meshwork is quite visible and most of the polyps are retracted flush with the surface. On the twigs the majority of the polyps are either exert or expanded sufficiently to rise above the surface as truncated cones. Sclerites from this colony (Fig. 9B) bear similarities to those of the species whose description follows this one. The percentage of crosses is higher than in the holotype and the angular processes are reduced in number and prominence. Although some bulbous forms are present, sclerites with gross in-filling are rare and the overall surface architecture is course.

Plumigorgia astroplethes sp.nov.
(Figs 13-15)

Type material. All material was collected from the Great Barrier Reef, Australia. HOLOTYPE - NTM C5001, Milln Reef, 16°147′S 146°17′E, 2 December 1976, 3-5 m depth, P. Alderslade. PARATYPES - USNM 76298, NTM C5000, NTM C5376, NTM C5377, same data as holotype; NTM C811, Moore Reef, 16°52′S 146°14′E, March 1978, 7 m depth, R. Schubot.

Diagnosis. *Plumigorgia* colonies with a bushy growth form, slightly flattened branches and a short main stem. Terminal branching alternate pinnate with thick coenenchyme often slightly expanded between the bases of the twigs. Axis highly calcified and often protruding from the tips of the twigs. Polyps evenly distributed over the whole of the colony and totally rectractile into the general coenenchyme. All but the innermost layers of the coenenchyme packed with multiradiate sclerites. Colour violet-grey when alive.

Description. The profusely branched colony (Fig. 13) is yellowish white. Terminal branching is pinnate and the pinnately branched sections are all more or less facing

Fig. 12. *Plumigorgia schuboti* paratype, NTM C766, sclerites with marked asymmetrical development.

Fig. 13. *Plumigorgia astroplethes* holotype. Natural size.

the same way. These sections are not, however, in the same plane and the resultant growth form is markedly bushy. The colony is 180 mm high, 85 mm wide and 70 mm deep.

The pinnate branching is alternate and the twigs are 1-2 mm, and occasionally 3 mm, apart. The length, thickness and orientation of these twigs is not regular. Regardless of the direction of growth of a branch the majority of twigs on it have curved and attempted to grow towards the apex of the colony. The twigs are round in cross section and taper slightly. Some have developed 1 or 2 twiglets. Most twigs are between 10 and 20 mm long. Some are only a few millimeters in length while others are extremely elongate and measure up to 50 mm.

The diameter of most twigs at their base is between 1.6 and 2.4 mm with the largest

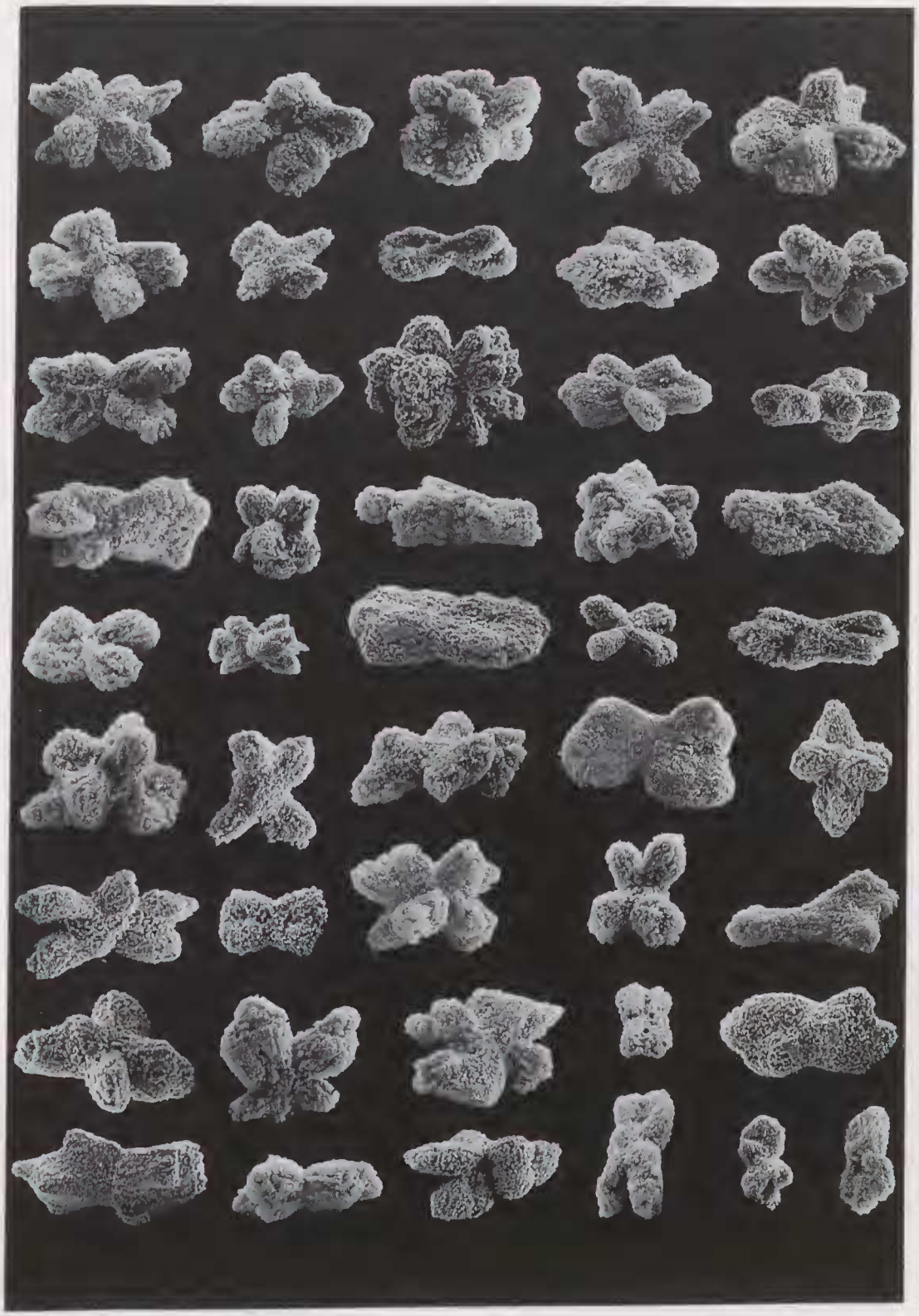

Fig. 14. *Plumigorgia astroplethes* holotype, sclerites.

being 2.7 mm. The coenchyme on the twigs is relatively thick. One twig with a diameter of 2 mm has a pale brown cylindrical axis measuring only 0.4 mm thick. The tips of the twigs can be bluntly rounded or conical. The latter often have a minute transluscent portion of the axis protruding from the end. Some of the twigs have up to 10 mm of white hair-like axis projecting from the tip.

The main stem is somewhat oval in cross section with one side slightly flattened and diameters of 7 mm and 5 mm. The axis is brown, longitudinally ridged, and covered with coenechyme about 0.6 mm thick. Most of the major branches are 4-5 mm thick and appear slightly flattened due to some expansion of the coenenchyme between the twigs. Except for the lower portions of the colony the axes of the branches are not ridged. They are mainly smooth with occasional lumps and rough patches.

The polyps are more or less evenly distributed over the whole of the colony, apart from the lower 25 mm, giving the specimen a faint speckled appearance. The polyps are fully retracted and appear as minute pale grey patches, sometimes star shaped, 0.05-0.17 mm across. Each is situated at the centre of a slight depression in the surface. The distances between polyps, both on the twigs and on the main branches, ranges from 0.35-0.70 mm. Those on the twigs, however, average closer together. In the area between the polyps numerous minute clear patches of

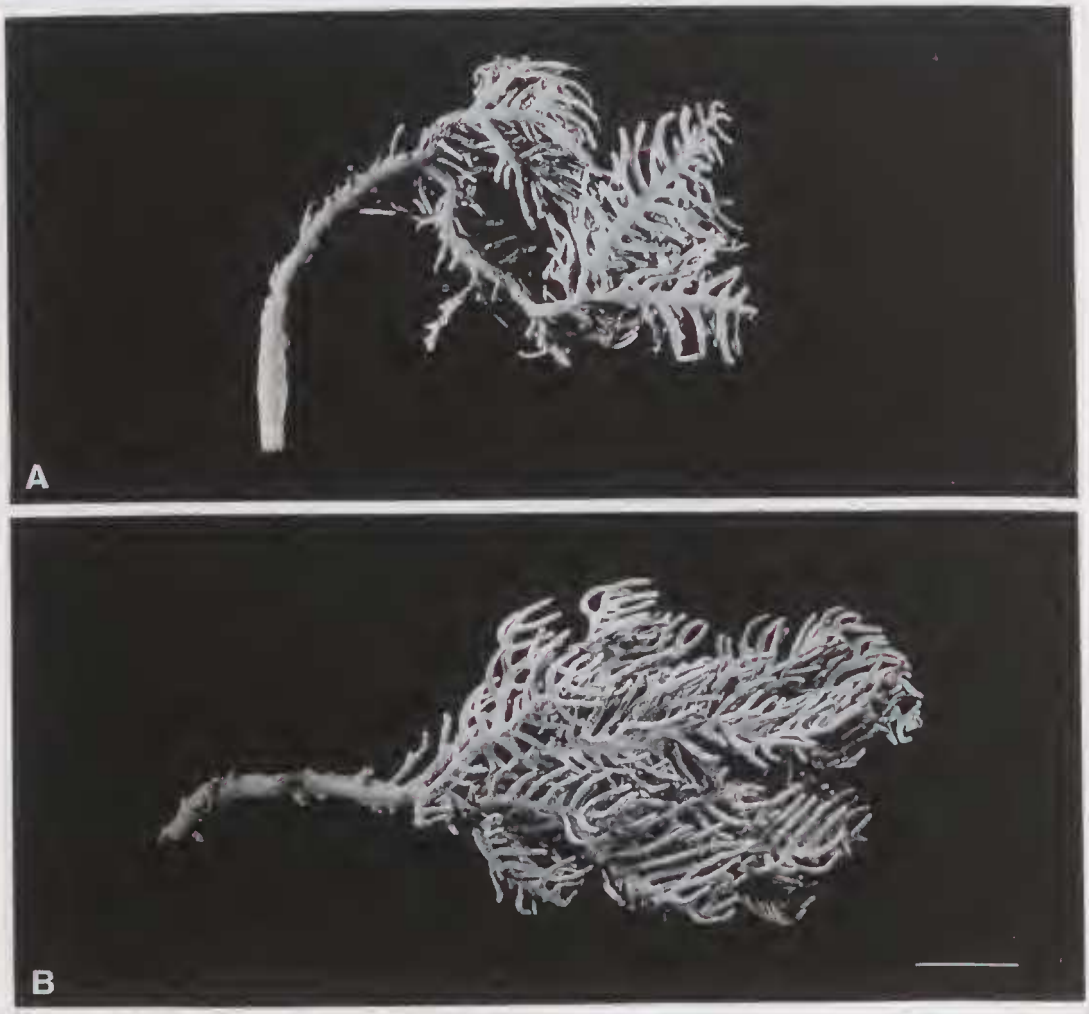

Fig. 15. *Plumigorgia astroplethes* paratypes: **A**, USNM 76298; **B**, NTM C5376. Scale 20 mm, both to same scale.

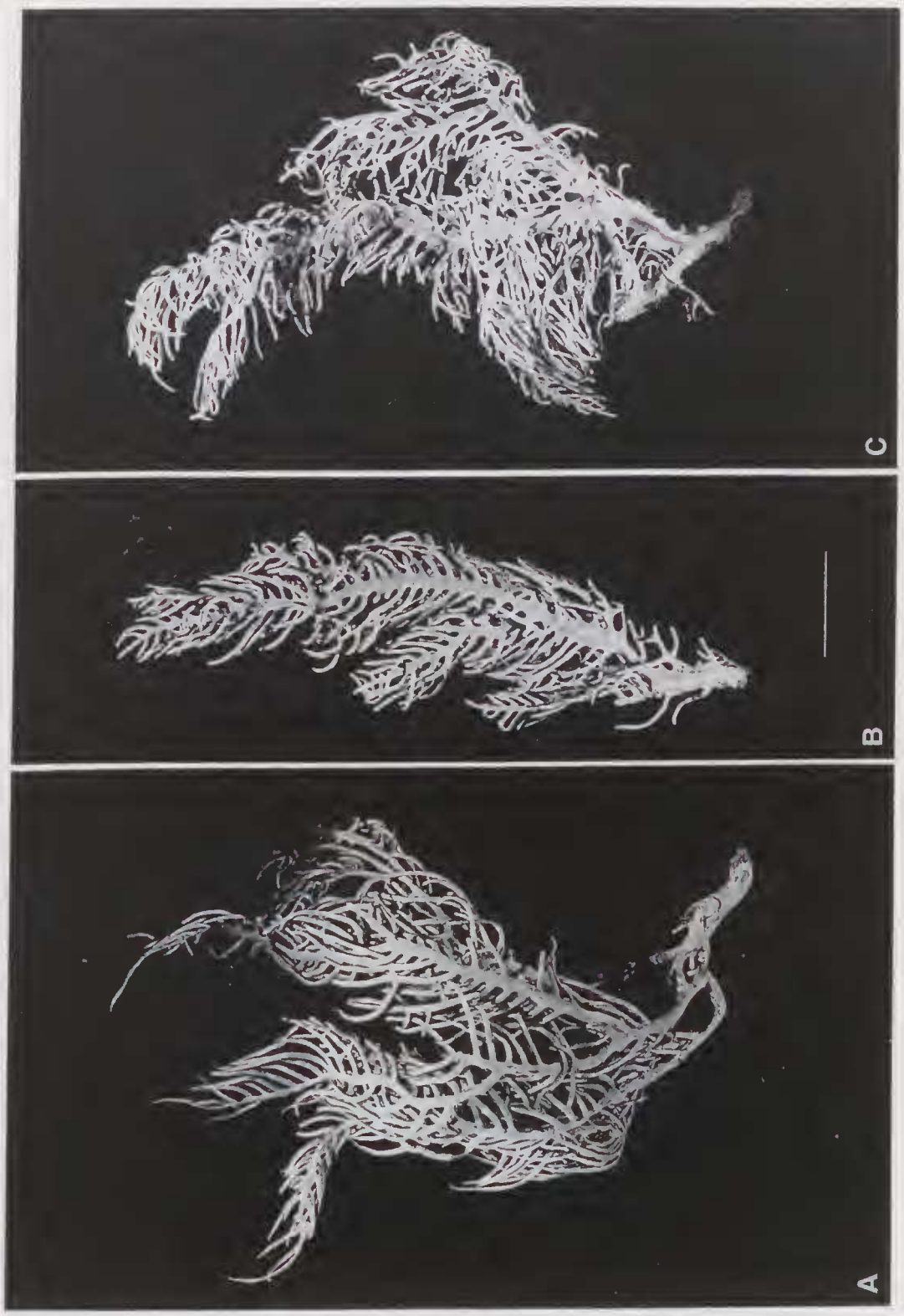

Fig. 16. *Plumigorgia astroplethes* paratypes: **A**, NTM C811; **B**, NTM C5377; **C**, NTM C5000. Scale 20 mm, all to same scale.

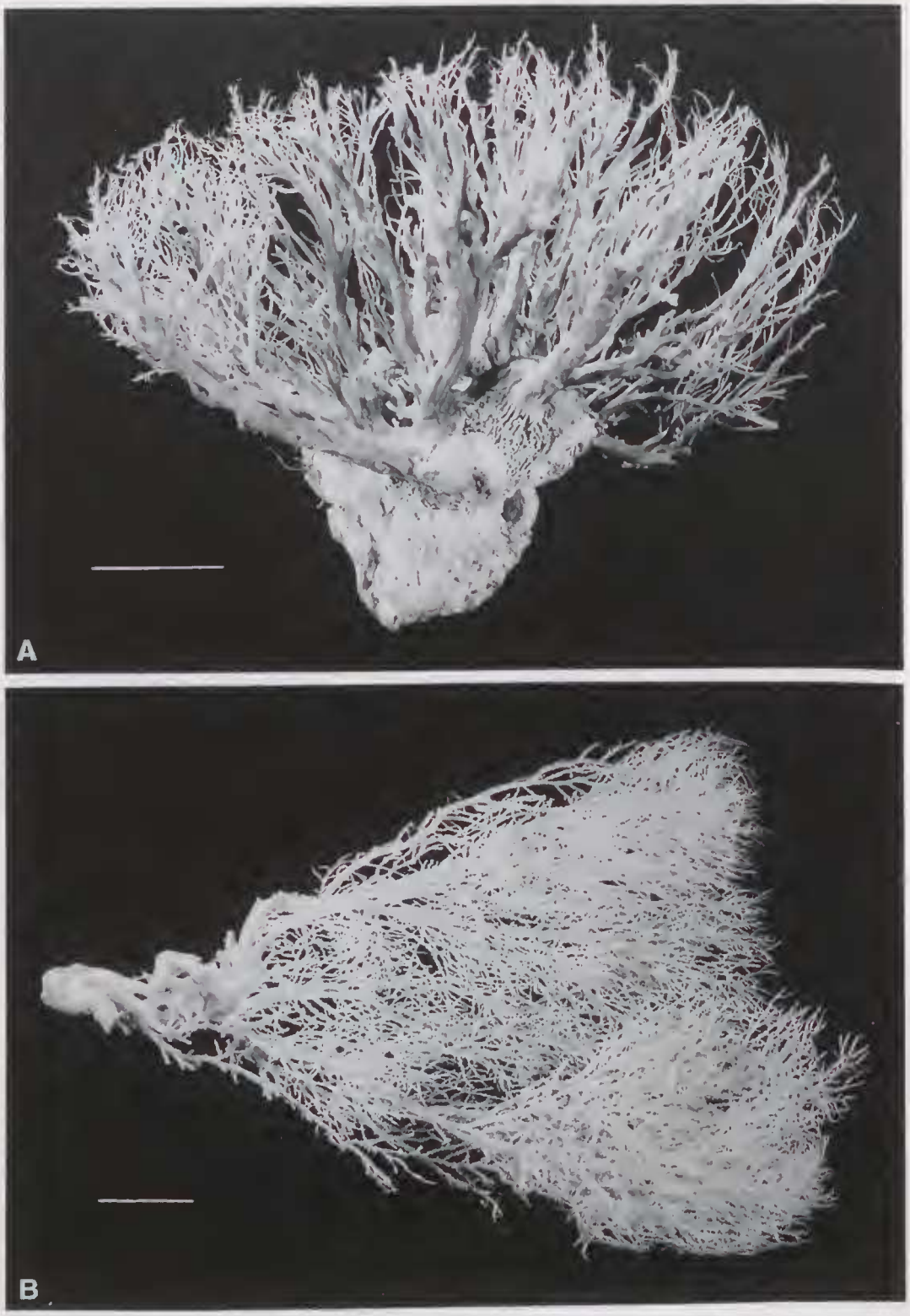

Fig. 17. *Ifalukella yanii*: **A**, paratype, USNM 51527; **B**, holotype. Scale 20 mm.

tissue 0.024-0.048 mm across are visible within the mass of sclerites.

The layer of coenenchyme outside the axial sheath and longitudinal stem canals is packed with minute sclerites. The sclerites (Fig. 14) are of a similar nature to the unusual crystal-like forms of the previous species. However, there is a marked lack of sharp angular ridges and projections, and forms exactly like those in Fig. 7 are absent. Most noticeable are the large numbers of crosses and multiradiates. Scattered among the multiradiates but not very common are sclerites similar to those of *P. terminosclera*, with a median constriction and commonly with a cavity in each half. The gross surface sculpture of the sclerites is different from that of the previous species and the sclerites appear darker under a light microscope. The longest sclerites are the rod-like forms which are up to 0.077 x 0.037 mm. The widest are the multiradiates which are up to 0.069 x 0.057 mm. The smallest measured was 0.033 x 0.016 mm.

Variability. Within the type series there is noticeable variation in the stoutness of the colonies. The holotype and two paratypes (Fig. 15) are markedly stouter than the other 3 specimens (Fig. 16). The former 2 specimens compare very well with the holotype but lack the few extraordinarily long terminal twigs. One of the slighter colonies, NTM C811, does have several very long twigs. All the twigs of this colony are very much slimmer than those of the holotype and taper much more rapidly to long thin tips. The coenenchyme of this specimen appears not to have undergone the same extent of shrinkage or contraction as that of the holotype as the clear tissue patches above the totally retracted polyps are wider and they are not in depressions on the surface. The surface of the branches has a more coarse appearance due partly to the sclerites being packed less tightly and partly to the sclerites being on the average larger than those of the holotype. The darker colour of the colony is a storage artefact. The remaining 2 slighter specimens NTM C5000 and NTM C5377 both have short, thin, twigs. The main branches appear markedly flattened due to extensive expansion of the coenenchyme along their edges. Specimen NTM C5377 is only a branch of a larger colony and in some areas of the expanded tissue the polyps appear in short distinct lines.

Sclerites do not vary greatly within the series. The sclerites of NTM C811 average larger, and those of NTM C5377 and NTM C5000 average smaller, than those of the holotype, but the size range is much the same. Sclerites from the latter 2 specimens also tend to be more angular.

Etymology. The specific epithet *astroplethes* is a direct use of the greek word which means "full of stars".

REVIEW OF THE FAMILY

In 1910 Nutting erected a new genus for several plumose gorgonian specimens collected by the *"Siboga"* expedition. He named the material *Plumigorgia hydroides* and placed his new genus in the family Gorgonellidae (now Ellisellidae). *P. hydroides* was characterised as pinnately branched and resembling a plumularian hydroid. The colonies had small calcified holdfasts attached to irregular calcareous masses and exceedingly fine branch axes. The polyps were very small and disposed bilaterally on the branches, and the sclerites were described as lenticular or disc-shaped and often having median constrictions. The genus did not appear in the literature again until 1940 when Stiasny identified specimens from the *"Snellius"* expedition as *P. hydroides*. Stiasny made the following reference to the sclerites: "Manche tragen ein oder zwei flache scheibenförmige warzen". He was almost certainly referring to the patches of lower density which are visible in some sclerites of this form and which show up as cavities in electron micrographs of chemically cleaned sclerites (Fig. 2A,C). Nutting, however, did not mention this phenomenon and an examination of his material showed only slight cavities similar to those in Fig. 2D, arrowed (not from Nutting's specimen). Stiasny's colonies exhibited a stouter growth form than Nutting's specimens and the biserial polyps were closer together.

The family Ifalukellidae was established by Bayer (1955) for a new genus and species of gorgonian from the Caroline Islands, *Ifalukella yanii* (Figs 17-18). In the same account Bayer erected a new species *Plumigorgia wellsi*, from the Marshall Islands, and reassigned *Plumigorgia* to the new family based on the characters of the

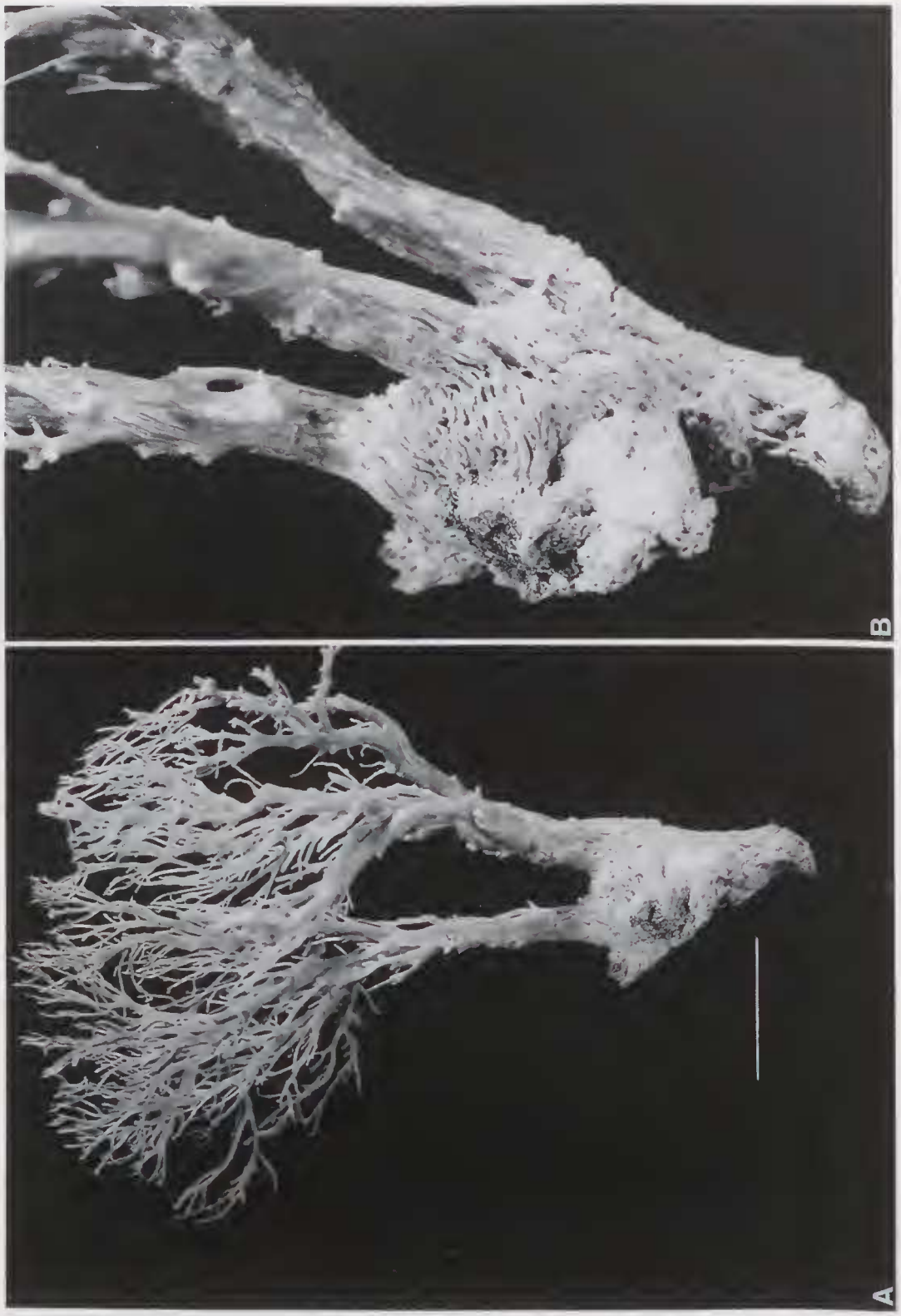

Fig. 18 *Ifalukella yanii* paratype, USNM 51527 : A, decorticated colony; B, heavily calcified base. Scale 20 mm.

axial calcification as well as the form of the sclerites. Specimens of *P. hydroides* from the China Sea were also referred to in the paper. Colonies of *Ifalukella* have very few sclerites. They are distinguished from *Plumigorgia* by their bushy non-pinnate growth form and massive calcareous base of attachment (Figs 17A,18B). *P. wellsi* is a stouter species than *P. hydroides*. The polyps are not biserial and the pinnate twigs branch at such shallow angles that the colonies do not have the feather or fish-bone-like appearance of *P. hydroides*. The sclerites of *P. wellsi* are also smaller with median constrictions being more pronounced, fewer flattened forms and the cavites shown in electron micrographs are far more common and far more distinct. Photographs of some of the type specimens of *I. yanii*, the holotype of *P. wellsi* and a large colony of *P. hydroides*, along with electron micrographs of the sclerites of the latter 2 species, are shown here for the first time (Figs 17-19), (an electron micrograph of a sclerite of *I. yanii* appears in Bayer et al. 1983, pl. 19 fig. 186). The photographs of the colonies are those of F.M. Bayer who also made it possible for me to examine fragments of the specimens. The colony of *P. hydroides* is a most luxurious specimen compared to Nutting's figured specimen and there are virtually no gaps between the polyps in the biserial rows. Dr Rob van Soest of the Instituut voor Taxonomische Zoologie, Amsterdam, made it possible for me to examine Nutting's material and, in contrast to his illustrated specimen, many of his syntypes have crowded polyps. It should also be noted here that the specimen illustrated by Nutting and that described by him in the text are not one and the same. In a bottle labelled "type" there are four colonies and some fragments (plus a small hydroid). The largest of these colonies, which is in very poor condition, has a main stem 2 mm wide at the base, branches 2-3 mm from the base and is approximately 135 mm high. It is attached to some dead coral and appears to be the colony referred to by Nutting in the text of his report. One of the smaller specimens corresponds to the bottom half of Nutting's illustration of a whole colony. By comparison the original colony must have been approximately 80-90 mm high when photographed. Because Nutting did not correctly specify a holotype I will designate this figured specimen, from Siboga Station 123, as the lectotype of the species. Although the specimen is incomplete it is in good condition and still has abundant sclerites. It is not clear whether this specimen and the other 2 small colonies were ever attached the base of the larger specimen. The specimens from Siboga station 96 are in another jar labelled "cotype". Six of these colonies are shown here in Fig. 20. The fine hair-like nature of the axes of the terminal branches is quite evident. As indicated by Nutting, it is extremely difficult to find any sclerites in the material from this station.

The definitions of the family Ifalukellidae and the genus *Plumigorgia* given by Bayer (1955, 1956) need only be slightly augmented to include the new species described in this paper.

Family Ifalukellidae Bayer

Diagnosis. Arborescent holaxonia with strongly calcified axes made up of gently undulating concentric lamellae; calcareous material not oriented in radial sectors; central chord not soft and cross chambered. Sclerites minute and of several forms; calcareous ovals, cylinders and platelets, some twin forms and some with median constrictions; angular rodlets and multiradiates, some with a highly crystalline appearance and prominent processes and ridges; surface structure irregularly granular; length 0.025-0.098 mm.

Genus *Plumigorgia* Nutting

Plumigorgia Nutting, 1910:32 (type species, *Plumigorgia hydroides* Nutting, 1910, by monotypy).

Diagnosis. Colonies pinnately branched, bushy or planar with a small calcified holdfast. Axis calcified but flexible. Polyps forming calyces or completely retractile within the general coenenchyme and may have sclerites. Coenenchyme maybe relatively thick. Sclerites absent to prolific, of all forms characteristic of the family.

Bayer's definition of *Ifalukella* (with a minor change) is given here for completeness;

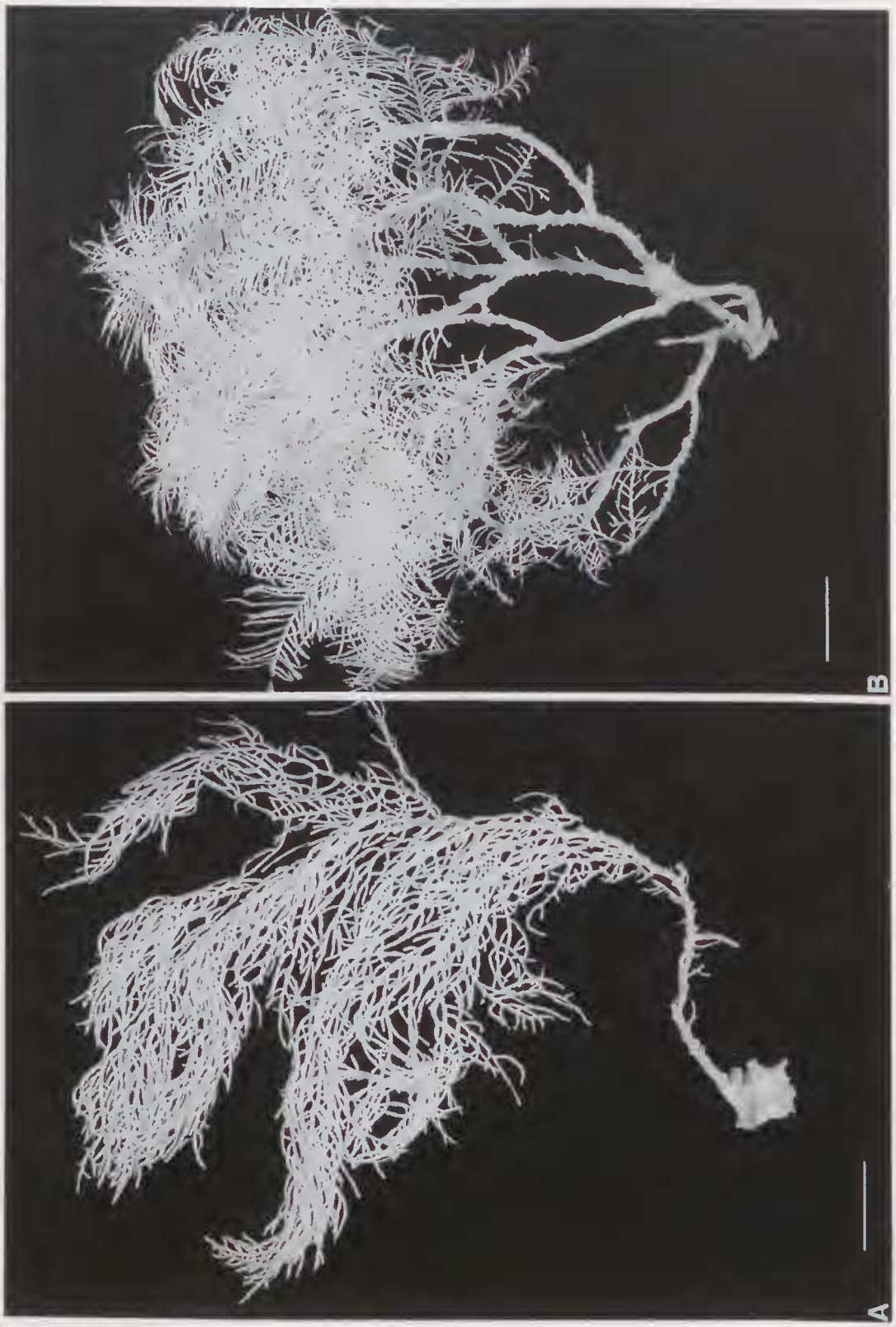

Fig. 19. A, *Plumigorgia wellsi* holotype; **B**, *Plumigorgia hydroides*, USNM 59811. Scale 20 mm.

Fig. 20. *Plumigorgia hydroides* paratypes, ZM Coel 3083. Natural size.

Genus *Ifalukella* Bayer

Ifalukella Bayer, 1955:213 (type species, *Ifalukella yanii* Bayer, 1955, by original designation and monotypy).

Diagnosis. Colonies low, arborescent, finely branched in an irregular, lateral pattern. Axis calcareous, brittle, spirally ridged, arising from a massive calcareous base on to which ridges extend as high crests with lobed or strongly laciniated edges that may produce small twigs, some of which may develop into full-sized colonies. Coenenchyme thin, polyps unarmed. Spicules very small, up to 0.035 mm in length, oval or elongate platelets of characteristic outline.

A key to the known species of the family is given below. Some comment is necessary on the usage of overall colony shape as one of the distinguishing factors between species. A number of workers have clearly demonstrated the effect of water movement on the growth form of octocoral colonies and, to a lesser extent, on sclerite morphology (e.g. Theodor 1963; Recs 1972; Grigg 1972). Grigg has necessarily pointed out that "Classification of gorgonian corals has depended heavily on the general form of the entire colony and the size and shape of the spicules. Because of the ecotypic variation of these characters, it is likely that many nominal species are not valid." It appears that for many species both planar and non-planar forms will increasingly be encountered. The last word, however, is still be said as there are a number of extremely common taxa which are often collected, such as the bushy *Rumphella aggregata* (Nutting, 1910) and the flabellate *Subergorgia mollis* (Nutting, 1910), that appear to never greatly diverge from their classical forms. Nevertheless, in view of the findings of Grigg and others one must be wary of placing too much weight on colony shape as a taxonomic character. But, in instances where deviation from a particular colony form is known only from a few cases, there is still an argument for the use of that species' common shape where, in a practical sense and providing possible divergence is pointed out, it can simplify a matter such as a taxonomic key.

A case to point is *P. hydroides*. In the original description of the species Nutting did not accurately detail colony form. He figured one small specimen and made no mention of the shapes of other syntypes. Stiasny, however, indicated that his material ramified more or less in one plane and in Bayer's key to the octocorallia (1981) the genus *Plumigorgia* is defined as "branching in one plane". An examination of Nutting's colonies, some of which are shown in Fig. 20, has revealed that a small degree of bushyness could be attributed to this species. A number of the smaller colonies branch considerably from, or just above, the holdfast and a number have branches that diverge "out of plane". Although some of these "out of plane" branches are broken others turn vertical and ramify more or less parallel to the main plane. In one colony an "out of plane" branch begins to ramify pinnately at right angles to the main plane, but the plume has twisted during growth to lie parallel to this plane. The specimen in Fig 19B, although stouter and more luxurious than any of Nutting's syntypes, shows a typical branching strategy in the lower half of the colony. The bushyness in this colony, however, is exaggerated by bottle storage and the terminal plumes lay more or less in one plane. Therefore, to avoid the item "Colonies planar but sometimes bushy" from making the key unnecessarily complex, *P. hydroides* is considered as planar.

Key to the genera and species

1. Family Ifalukellidae,
   a. Colonies pinnately branched, bushy or planar, holdfast small and calcified: Genus *Plumigorgia* 2
   b. Colonies laterally branched, bushy, with massive calcareous holdfast. Sclerites scarce, oval or elongate platelets: Genus *Ifalukella* ..... *I. yanii* Bayer
2. Colonies pinnate, Genus *Plumigorgia*,
   a. Colonies bushy. Polyps not biserial. Sclerites mainly multiradiates: .... *P. astroplethes* sp. nov.
   b. Colonies planar: 3
3. Colonies planar,
   a. Polyps not biserial. Sclerites highly crystalline rodlets, ovals and crosses, with angular prominences: ..... *P. schuboti* sp.nov.
   b. Sclerites ovals, cylinders and platelets, often with median constrictions: 4

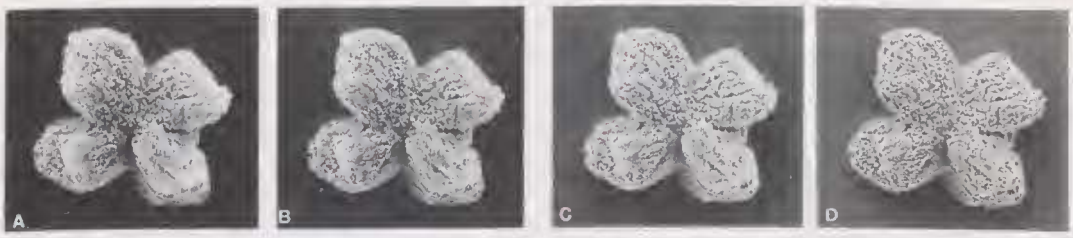

Fig. 21. Scanning electron micrographs at different accelerating voltages : **A**, 25 kv; **B**, 20 kv; **C**, 15 kv; **D**, 10 kv.

4. Sclerites ovals, cylinders and platelets,
   a. Polyps not biserial. Sclerites ovals, and cylinders, scarce (sometimes absent) and clustered primarily at the ends of the twigs: ... *P. terminosclera* sp.nov.
   b. Polyps not biserial. Sclerites ovals, cylinders and platelets, often with pronounced median constrictions, densely aggregated over whole colony: ..... *P. wellsi* Bayer
   c. Polyps biserial: 5
5. Polyps biserial,
   a. ..... *P. hydroides* Nutting

The key is so designed that entry is possible at any point, 2-5, after the first couplet.

GEOGRAPHIC DISTRIBUTION

The distribution of the group is only known from 6 isolated occurrences. The apparent range extends from north eastern Australia through central Indonesia to the northern Philippines and out into the central West Pacific. The only collection of *Ifalukella* was from quite shallow water. *Plumigorgia* has been obtained from a similar depth down to 20 fathoms.

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